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Editorial: Special issue on mobile P2P networking and computing

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Peer-to-Peer networking first emerged as an overlay technique to support distributed file sharing over the Internet. Since then, P2P networking and computing have gradually evolved into a system framework that delivers a broad range of distributed and scalable resource discovery and sharing applications including efficient search of data items and people using context/key based routing, application level multicast, redundant storage, video streaming, etc. Striving for automated formation, distributed operation and effective resource sharing, peers form self-organizing overlay networks and offer services beyond the traditional client-server paradigm of Internet by entrusting symmetry in roles and requiring no or fewer pre-established servers.

Today, mobile end devices are one of the major participants in information gathering, processing, dissemination and consumption. Supporting the P2P networking and computing paradigm in this ever growing mobile communications environment has become an appealing idea. The key attraction of the Mobile P2P (MP2P) paradigm is its ability to scale without requiring expensive and manually configured servers, and to sustain failure points through automatic recovery of a fully distributed structure.

Compared with wired networks, it is generally more difficult to set up and maintain centralized servers in some mobile networks, such as in the Mobile Ad hoc Network (MANET). It may also be generally possible to harvest efficiency gains through sharing applications and contents among peer mobile end devices directly rather than backhauling them to a centralized server in the fixed backbone network. Though the P2P paradigm may naturally suit well the distributed and dynamic wireless communications environment, support of MP2P is particularly challenging considering the special characteristics of the mobile networks. The highly variable connectivity, frequent disconnection, location-dependency, energy and resource constraints, diversity in wireless end devices and as well the carrier-grade performance requirements when offering business level applications bring about some critical issues in facilitating the MP2P paradigm. The mobility of the users may increase dramatically the churn in the peer systems to engender extra overhead when employing P2P overlay protocols. The limited bandwidth and constrained battery resource available to the wireless device aggravate the hindrance and may even render the P2P overlay mechanism infeasible in operation. Due to resource limitations, mobile peers can be inclined to the selfish free-rider behaviour in data sharing and downloading. The

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applications supported in the MP2P environment have thus more impediments to the robustness of performance than they would in a wired P2P system.

This special issue aims to present recent advances in the research of MP2P networking and computing, with a focus on proposing extended applications and improving the system performance. It includes six high quality papers selected after peer review from 17 submissions.

Video sharing has become increasingly popular over the Internet, so has the research on delivering video streaming through P2P overlays. The first two papers of this issue present two different systems that expand the video streaming applications. Instead of being a simple video consumer in the network, mobile end devices take peer roles in video delivery and adaptation in an MP2P streaming overlay. In the first paper, "PatchPeer: A Scalable Video-on-Demand Streaming System in Hybrid Wireless Mobile Peer-to-peer Networks", T. Do et al. present a novel MP2P video streaming architecture that is comprised of both an infrastructure based carrier wireless network and an ad hoc mobile end device network. Leveraging the high availability assurance of the carrier infrastructure wireless network and also the opportunistic resource usage of the ad hoc mobile peer network, the proposed PatchPeer technique can scale the video-on-demand service beyond the bandwidth capacity of the server. The solution moves forward the traditional video patch scheme which is implemented on the video server in the network by employing a MP2P structure to patch streams through the mobile peer nodes. The analysis and simulations presented in the paper have demonstrated the improved scalability and performance of the PatchPeer system compared with the current state-of-art techniques. The second paper, "DAg-stream: Distributed Video Adaptation for Overlay Streaming to Heterogeneous Devices" by Iqbal et al. applies the MP2P structure for efficient video adaptation and streaming to deliver video services to heterogeneous mobile end devices. Mobile handheld devices are typically heterogeneous in their capabilities of screen resolution, processing power and bandwidth, which require video adaptation into different levels to befit. The authors examine the video adaptation process using MPEG-21 gBSD (generic Bitstream Syntax Description) and propose a novel MP2P video streaming architecture that distributes not only the streaming bandwidth burden to the peer nodes, but also the computation load of video content adaptation to the capable peer devices. Their simulations have shown promising performance results which are compared against those of a theoretically optimal approach.

It has been observed that the churns originated from the presence of dynamic mobile peers in a MP2P overlay can be detrimental as it may cause a major failure of the applications in the MP2P overlay. Robustness of applications in MP2P computing is a major issue. While ensuring robustness is traditionally handled through replication or redundancy, in the third paper, "Improving Robustness of P2P Applications in Mobile Environments", a novel method is proposed by Roczniak et al. which is based on the observation that some redundancy exist between services offered on the network. Exploiting the redundancy of services existing in the system, the proposed solution recreates an unavailable service from the services accessible to a peer. The general methodology is established, by applying the finite-state transducers to model the interactions with services and to derive a set of algorithms that can recreate the interaction with the lost service using the still accessible service(s). The authors have illustrated that the computational cost of this approach is polynomial with respect to service's size, provided that the non-redundant functionality and related control are available or can be implemented locally at a peer.

The issue of peer cooperation in MP2P environments needs to be carefully understood and effectively treated. The next two papers in this special issue address the mobile peer cooperation problem. In the fourth paper, "An Economic Incentive Model for Encouraging Peer Collaboration in Mobile-P2P Networks with Support for Constraint Queries", Madria et al. propose an economic incentive model, employing a broker-based MP2P approach organizing distributed multidimensional index trees for the efficient processing of constraint queries in MP2P networks. Their performance studies demonstrate that the proposed mechanism can improve the query response time, success rate, data quality, and data availability compared with existing schemes. The fifth paper of this issue, "Mastering Selfishness in Cellular Mobile P2P Content Distribution Networks with Multiple Source Download in Cellular Networks", by Schlosser et al. has taken a different approach by studying the selfish behaviour of peers in the MP2P file sharing network. They evaluate several different peer cooperation strategies in the MP2P scenarios where selfish "leeching peers" are involved in the network. The cooperation strategy proposed by the authors for these practical scenarios is shown to improve the content distribution performance applying only local information available to the peers to attain control efficiency.

The sixth paper studies the mobility management issue of MP2P overlays in a mobile ad hoc network deployed for mission critical operations. This type of mobile tactical

network is one of the important applications of the MANET. In this paper, "Subscriber Mobility Management for a P2P Publish/Subscribe Overlay in Mobile Tactical Networks", Gaddah et al. have devised a publish/subscriber model using MP2P over the requirements stringent mobile tactical network to deliver a realtime information dispatch service. The authors investigate the mobility issues of the subscribers and propose a proactive scheme to offer a required fast peer handoff procedure. They also establish an analytical model to describe the handoff overhead associated with different schemes and develop a test bed to evaluate and compare the performance of three major schemes through extensive simulation experiments.

In closing, we would like to thank all the authors who submitted their work to this special issue as well as the reviewers who, through their expert and insightful comments, helped improve significantly the quality of the submitted material. We would also like to thank the Editor-in-Chief Prof. Sherman Shen, the Associate Editor Dr. Heather Yu and the editorial assistants Valerie Schofield and Christina Chua for their continued guidance and professional support throughout all the phases of this publication. We hope you will find the material in this special issue on Mobile Peer-to-Peer Networking and Computing interesting and useful.

Dr. Li Li is a research scientist at Communications Research Centre (CRC) Canada. Prior to joining CRC in 2003, Dr. Li worked in the Telecommunications Industry as system architect and product manager. Li contributed to ITU-T, IETF standard working groups and published in international conferences and research journals. She co-authored IETF RFC and has been awarded with several US patents. Dr. Li has served as Co-chair for the IEEE PERCOM MP2P'06-08 workshops, as session co-chair for IEEE MILCOM'08, and as TPC member for many international conferences. Li received her Ph.D in Electrical Engineering from University of Ottawa, Ottawa, Canada. Her current research focuses on mobile tactical radio networking and adaptive networks, with particular interests in mobile network optimization, mobile P2P, node localization, and performance modeling of mobile networks.

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Kurt Tutschku holds the Chair of "Future Communication" (endowed by Telekom Austria) at the University of Vienna. Before that, he was an Assistant Professor at the Department of Distributed Systems, University of Wuerzburg. He led the department's group on Future Network Architectures and Network Management until December 2007. From Feb. 2008 to July 2008, he worked as an Expert Researcher at the NICT (National Institute for Information and Communication Technology, Japan). Kurt Tutschku has received a doctoral degree in Computer Science from University of Wuerzburg in 1999 and completed his Habilitation ("`State Doctoral Degree'") at the University of Wuerzburg in 2008. His main research interest include future generation communication networks, Quality-of-Experience, and the modeling and performance evaluation of future network control mechanisms and P2P overlay networks.